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SAW APPARATUS AND FEED APPARATUS THEREFOR

TECHNICAL FIELD

The present invention relates to a saw apparatus and a feed apparatus therefor. In particular the invention relates to a saw apparatus for cutting truss and framing members for buildings in predetermined lengths and at predetermined angles using a feed apparatus to accurately feed these to the saw apparatus in a controlled manner. However, it is to be understood that the invention is not to be limited as such. Moreover, because the invention may have many other applications, the prior art and possible applications of the invention discussed below are given by way of example only.

BACKGROUND ART

Conventional apparatus for cutting lengths of wood such as framing members for buildings generally comprise a horizontal saw bench fitted with guides to align the wood, a saw blade which can be moved in the horizontal plane and turned through different angles, and which can be retracted beneath the saw bed, and a feed device for feeding the length of wood to the saw blade position. In cutting the predetermined lengths using a computer controlled apparatus, data related to the size and length of the wood is input to a program which computes the optimum lengths of framing members to be cut from the piece of wood, resulting in the minimum amount of scrap. The wood is then fed to the cutting position with the feed device and cut by moving the blade horizontally at a required angle to give the various lengths of wood with the ends cut at the required angles.

In the case of cutting very long inclined ends (small angles), the wood may be positioned above the blade position with the blade retracted, after which the blade is raised to cut the wood. This operation inevitably requires an additional device for holding the wood down onto the saw bench, and also requires a large diameter blade, thus adding to the cost of the saw apparatus.

The cutting of very long inclined ends may also be achieved with a small blade which is moved along the direction of the cut. In this case, due to the length of the cut the blade must be moved a considerable distance and hence the time for the cutting operation is longer.

Moreover, with conventional cutting methods, the removal of the sawdust from the cut area can be a problem. In particular, in the case where the blade is raised up

through the wood, when the blade breaks through the top of the wood, the sawdust is no longer guided by the cut area and can spray haphazardly into the work area, making collection difficult.

In addition with conventional saw apparatus, since the saw bench is generally horizontal, wood cut offs, and chips collecting on the surface must be continuously swept from the surface, thus hindering operation.

Furthermore, with conventional systems where the feed device is in the from of a pushing member which may also be adapted for gripping the end of the length of wood, there is a disadvantage in that it takes time for the pushing member to be retracted back to the start position when a new length of wood is positioned ready for cutting. Moreover, there is a disadvantage in that in bringing the pushing member up to the new length of wood, the speed of the pushing member must be carefully controlled to avoid bumping the wood.

DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a saw apparatus which addresses the above problems with conventional methods and apparatus for cutting wood, or which at least provides the public with a useful choice.

Moreover, it is an object of the present invention to provide a feed apparatus for accurately feeding and positioning lengths of material, such as in the case of lengths of timber to be cut by a saw apparatus.

Furthermore, it is an object of the present invention to provide a saw dust removal device that addresses the aforementioned problems.

According to a first aspect of the present invention there is provided a saw apparatus comprising:

a saw bench for supporting a length of material to be cut on a plane of the saw bench;

a feed device for feeding a length of material to be cut in a direction of feed relative to the saw bench, while being supported by the saw bench, and while the length of material is being cut, and

a circular saw blade assembly comprising:

a base member mounted relative to the saw bench so as to be movable in a transverse direction across the direction of feed, and

a saw blade mounting device for rotatably mounting a circular saw bladė on the base member at a predetermined angle relative to the transverse movement direction of the base member in the plane of the saw bench, and having a device for connection to a drive source for rotating a circular saw blade when mounted thereon (or comprising a drive device).

With such a construction, a circular saw blade mounted on the circular saw blade assembly can be inclined to the transverse movement direction of the base member and moved across the direction of feed at an incline to the direction of feed. Hence a length of material can be cut while being fed along the saw bench in a direction of feed relative to the saw bench. Long angle (small angle) cuts can thus be made by simply inclining the circular saw blade to the required angle, and moving the circular saw blade transverse to the direction of feed while feeding the length of material in the direction of feed.

Hence angle cuts can be made with a small diameter blade compared to the conventional method of using a large diameter blade which is raised up through the wood. Moreover, the amount of transverse movement is much less than in the conventional case where the blade is aligned with the direction of transverse movement and is moved along the cut while the length of material remains stationary.

Furthermore, since the cut is through the timber rather than from beneath, the direction of sawdust is always on the outlet side of the cut, except perhaps at the final cut through the edge on completion of the cut.

The predetermined angle of the blade relative to the transverse movement direction of the base member in the plane of the saw bench may be achieved by providing an angle adjustment device for adjusting the angle of mounting the saw blade mounting device relative to the base member. Furthermore, there may be provided a blade depth adjusting device for adjusting the depth of the blade relative to the base member.

It is generally envisaged that in order to facilitate standard 90 degree cross cuts, the base member would be mounted so as to be movable transverse to the direction of feed, and the angle adjustment device would enable angle adjustment from zero degrees (for cross cuts) to a predetermined maximum angle which may be up to 360 degrees (for cross cuts in the opposite direction). By enabling the full angular adjustment

through 360 degrees, the saw blade can be operated to cut all angles with the material being cut being moved in either direction.

The saw bench may be arranged horizontally so as to support the length of material resting thereon, and be provided with a guide for guiding the length of material in the direction of feed. Alternatively the saw bench may be arranged at an angle to the horizontal, as required or desired.

According to another aspect of the present invention, there is provided a saw apparatus substantially as described above, wherein the saw bench comprises two inclined support devices for supporting a length of material along a support plane, the support devices being inclined relative to each other, and being inclined to a horizontal plane. It is generally envisioned that the support devices would be inclined at right angles to each other, to thereby provide optimum support for rectangular lengths of material to be cut. However, other angles may be appropriate depending on requirements.

With such an arrangement, a length of material to be cut can be positively supported on the saw bench by its weight holding it against the inclined surfaces. Hence alignment of the length of material can be easily achieved by using the weight of the length of material to position the length of material. Moreover, by having the saw bench inclined to the horizontal, the various components of the circular saw blade assembly can be more easily accommodated in the overall structure, and more easily accessed. Furthermore, having the saw bench at an incline overcomes the problem with conventional horizontal saw benches with wood cut offs, and chips collecting on the surface.

The feed device may comprise a conventional feed device such as one where a pushing member pushes against the end of the length of material to advance the material to the cutting position. In this case, the material may be held in position by rollers along the feed path which are biased against the surface of the material.

According to another aspect of the present invention, there is provided a saw apparatus substantially as described above, wherein the feed device comprises:

a conveyer belt suspended between belt support rollers which are rotatably mounted on a base structure, at least one of the rollers being adapted for connection to a drive device for driving the conveyer belt, and

a clamping device mounted relative to the base structure for clamping a member to be fed against an outer peripheral surface of the conveyer belt.

With such an arrangement, a length of material to be cut can be fed in the direction of feed by positioning the material on the conveyer belt and holding the material against the conveyer belt with the clamping device while rotating the conveyer belt. By using a conveyor belt feed device, the disadvantage in operating time with the conventional feed device which uses a pushing member is overcome.

The conveyer belt may be any suitable conveyer belt which can sufficiently grip the material to be fed when this is held thereagainst by the clamping device.

For example this may comprise a toothed belt type conveyer belt comprising metal hoop wires embedded in a synthetic resin material with teeth formed on the inner peripheral surface.

From tests done using such a conveyor belt type feed apparatus, it was found that the material could not be accurately fed in proportion to the number of revolutions of the conveyor belt. For example, when feeding a length of 100mm x 50mm wood, of around 6 meters length, the feed length determined by measuring the number of rotations of the conveyor drive roller was inconsistent, with errors of up to 0.5mm per metre. Hence such a feed apparatus with a standard toothed conveyor belt could not be used for accurate cutting of members such as truss and framing members.

The present inventor considered this problem to be due to lengthwise expansion and contraction of the conveyor belt with the loading applied by the clamping device clamping the length of material against the conveyor belt surface. To minimise this lengthwise expansion and contraction, the present inventor therefore formed a plurality of continuous grooves around an outer peripheral surface of the conveyor belt so that expansion and contraction of the belt with the applied loading could be absorbed by sideways deformation rather than lengthwise deformation. From tests made with such a grooved belt it was found that the previous lengthwise inconsistency in feed measurement when feeding a length of 100mm x 50mm wood, of around 6 meters length, could be reduced to around 0.005 mm per metre.

Therefore, according to another aspect of the present invention there is provided a saw apparatus substantially as described above, wherein the conveyer belt comprises a toothed belt with a plurality of continuous grooves formed around an outer peripheral surface.

By providing continuous grooves in the outer peripheral surface, more accurate feed can be achieved, for the reasons described above.

While the above described feed device is particularly applicable to the saw apparatus of the present invention, the feed device is not limited to this application, and may be suitable for a variety of applications requiring accurate feeding and positioning of lengths of various types of materials.

According to another aspect of the present invention, there is provided a feed device comprising:

a conveyer belt suspended between belt support rollers which are rotatably mounted on a base structure, at least one of the rollers being adapted for connection to a drive device for driving the conveyer belt, and

a clamping device mounted relative to the base structure for clamping a member to be fed against an outer peripheral surface of the conveyer belt, wherein the conveyer belt is formed with a plurality of continuous grooves around a peripheral surface thereof.

By forming the continuous grooves around an inner or outer peripheral surface of the conveyor belt, then as mentioned above, the expansion and contraction of the belt with the transverse compressive loading can be absorbed by sideways deformation of the belt rather than lengthwise deformation.

To enable accurate measurement for determining feed, the conveyor belt is preferably a toothed conveyor belt, and the continuous grooves are formed around the outer peripheral surface of the conveyor belt.

Moreover, there is provided a method of reducing lengthwise deformation of a conveyor belt when loaded with a transverse compressive load, the method involving forming continuous grooves around a peripheral surface of the conveyor belt.

The saw apparatus of the present invention also comprises a saw dust removal device for removing saw dust as this is discharged from the cut.

The saw dust removal device may comprise an intake located relative to the saw blade in the vicinity of the teeth exiting from the cut, and a suction duct connected to the intake for drawing air in through the intake, wherein the suction duct constitutes a hollow support member of the circular saw blade assembly.

While the above described saw dust removal device is particularly applicable to the saw apparatus of the present invention, the saw dust removal device is not limited to

this application, and may be suitable for a variety of applications requiring removal of saw dust from a cutting region.

Therefore according to another aspect of the present invention there is provided a saw dust removal device for the circular saw blade assembly, comprising an intake located relative to a saw blade of the circular saw blade assembly in the vicinity of the teeth of the saw blade as they exit from a cut, and a suction duct connected to the intake for drawing air in through the intake, wherein the suction duct constitutes a hollow support member of the circular saw blade assembly.

The present invention may also broadly be said to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of the parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

BRIEF DESCRIPTION OF THE DRAWINGS

Further aspects of the present invention will become apparent from the ensuing description which is given by way of example only and with reference to the accompanying drawing in which;

FIG. 1 is a schematic diagram illustrating a method of the present invention for making angled cuts in elongate members;

FIG. 2 is a schematic elevation view of a saw apparatus according to an embodiment of the present invention;

FIG. 3 is a schematic diagram showing details of an outfeed device, (A) showing a plan view illustrating a sideways operating mechanism, and (B) showing details of operation in stacking cut wood.

FIG. 4 is a schematic diagram showing details of a feed device, (A) showing a view in the direction of arrow A of FIG. 2, and (B) showing a cross sectional view on B-B of (A) illustrating details of a conveyor belt;

FIG. 5 is a left end view of the saw apparatus of FIG. 2, illustrating components of a saw bench and clamping device;

FIG. 6 is a right end schematic view of the saw apparatus of FIG. 2, illustrating components of a circular saw blade assembly and saw dust removal device;

FIG. 7 is an enlarged schematic view of the saw blade assembly shown in FIG. 6.

FIG. 8 is a flow chart illustrating the steps in operation of the saw apparatus of the embodiment of the invention.

FIG. 9 is a flow chart illustrating the steps in a sub-routine of the flow chart of FIG. 8, for measuring a length of material to be cut.

BEST MODE FOR CARRYING OUT THE INVENTION

An embodiment of the present invention will now be described with reference to FIG. 1 which illustrates a method of the present invention for making angled cuts in elongate members using a circular saw bench (not shown) along a plane of which (plane of the page in FIG. 1) an elongate member 1 can be fed in a direction of feed Y. The method involves mounting a circular saw blade 2 so as to be movable in a direction X transverse to the direction of feed Y in a plane parallel to the plane of the saw bench. This may involve a conventional mounting device such as used for cross cut circular saw apparatus. In FIG. 1 this transverse direction X is shown as perpendicular to the direction of feed Y, however the circular saw blade 2 may be mounted so as to be movable at some other suitable angle as required or desired. It is generally envisioned that the circular saw blade 2 would be mounted so as to be movable at an angle close to 90 degrees to the direction of feed Y, since increasing the angle increases the distance to be moved by the circular saw blade 2, which defeats one object of the invention which is to reduce the distance to be moved by the circular saw blade 2 in the case of cutting long angles. In the figure, the long angle is shown as θ.

Moreover, the circular saw blade 2 is shown mounted perpendicular to the plane of the saw bench (plane of the paper in FIG. 1). However depending on requirements the circular saw blade 2 may be mounted at an incline to the plane of the saw bench.

The method further involves inclining the circular saw blade 2 at a predetermined angle to the transverse direction X in a plane of the saw bench (plane of the paper in FIG. 1). This incline may be achieved by an adjustable mount between a saw blade rotational support device and a transverse movement device. Cutting of the angle on the end of the elongate member 1 is then achieved by feeding the elongate member 1 along the saw bench in the direction of feed Y while synchronously moving the circular saw blade 2 in the direction X transverse to the direction of feed Y.

FIG. 1 shows the various stages in cutting the angle on the end of the elongate member 1. At position "a", the blade 2 is clear of the member 1 ready to be moved in direction X while the member 1 is moved in the direction Y so as to start cutting at a'. At position "b", the blade 2 has started to cut an angled cut in the member 1, the end of the member 1 being at b'. At position "c", the blade 2 has cut through the member 1 leaving the section c' to fall away. At position "d", the blade 2 is clear of the member 1 allowing the member 1 to be fed along the saw bench into a new position for cutting if required. Since the blade 2 can be turned through 360 degrees, the end of the member 1 can be cut at various angles while being moved forward or backward in the Y direction, with the blade 2 being moved forward or backward in the X direction.

With the method illustrated in FIG. 1, long angles θ can be cut in elongate members 1 with only minimal transverse movement of the blade 2. Hence cutting time can be reduced. Moreover, compared to apparatus using a large diameter blade which is raised from beneath the member being cut, the saw dust from the cut can be better controlled since the only uncontrolled period is when the blade 2 clears the cut at position d'.

FIG. 2 through FIG. 7 illustrate a saw apparatus 10 according to an embodiment of the present invention. The saw apparatus 10 of this embodiment is an inclined structure comprising two saw benches generally indicated by arrow 12, one at each end of the saw apparatus 10. Each saw bench 12 comprises two inclined support devices, one major support device 14 comprising two rows of rollers 14a and 14b for supporting a length of material to be cut on a plane inclined at approximately 20 degrees to the vertical, and a minor support device 16 comprising one row of rollers 16a with a support plane thereof inclined at right angles to the support plane of the major support device 14.

The minor support device 16 at the right hand end in FIG. 2 and as shown more clearly in FIG. 3A, is mounted on the main frame by means of linear bearings 17 so as to be movable sideways. Due to this arrangement, material being cut can be easily discharged to below the feed path Y if required by moving the minor support device 16 away from the feed path Y. This is particularly useful in the case of cutting short members. The reason for having the linear bearings 17 arranged at an incline to the support device 16 as shown in FIG. 3 is to obviate the need for an anti skew device which would be required if they were aligned perpendicular to the support device 16. Sideways movement of the support device 16 for discharging material which has been cut is achieved by operation of a discharge pneumatic actuator 17'.

Also as shown in FIG. 3, there is provided an outfeed device generally indicated by arrow 140. In FIG. 3, components the same as in FIG. 2 are denoted by the same reference symbols. The outfeed device 140 extends approximately 3 meters from the end of the right end major support device 14 (FIG. 2), for supporting and stacking long lengths of wood as they are discharged after being cut. The outfeed device 140 also comprises an arrangement for discharging the material which has been cut to below the feed path Y which is operated similarly to the right end minor support device 16 as described above. That is, there is provided a minor support device 160 comprising one row of rollers 160a with a support plane thereof inclined at right angles to the support plane of the major support device 14. The minor support device 160 is mounted on the opposite side of the feed path Y to the support device 16, on a main frame (not shown) of the outfeed device 140 by means of linear bearings 170 so as to be movable sideways. The sideways movement of the support device 160 for discharging material which has been cut is achieved by operation of a discharge pneumatic actuator 170'. As shown in FIG. 3B, by moving the support device 160 sideways, in synchronous with the cutting operation of the wood, in the sequence indicated by the arrows in FIG. 3B, then the wood 1 as it is fed out from the saw apparatus 10 is first supported on the rollers 160a, while still being supported on the rollers 14a and 14b of the major support device 14 (top position in FIG. 3B). Then once the wood has been cut, the support device 160 is moved sideways (to the right in FIG. 3B) away from the feed path Y so that the cut wood can drop downwards from the feed path Y and onto a rack 180 (bottom position in FIG. 3B). The support device 160 is then moved sideways towards the feed path Y (to the left in FIG. 3B), so that the rollers 160a are again brought into position for supporting a new length of wood. At the same time a pusher member 162 of the support device 160 pushes the cut wood 1 which has just dropped onto the rack 180, sideways to thus stack the cut wood on the rack 180.

Moreover with the present embodiment, each saw bench 12 is provided with a feed device generally indicated by arrow 18 for feeding a length of material supported by the saw bench 12, in a direction of feed Y relative to the saw bench 12.

The feed devices 18 as more clearly shown in FIG. 4 each comprise: a toothed belt type conveyer belt 20 suspended between belt support rollers 21 and 22 which are rotatably mounted on bearings (not shown in the figures) mounted on a base structure of the saw bench 12. Idler rollers 23 are also provided for supporting the conveyor belt along its length. One of the belt support rollers 22 is connected to a drive shaft 24 (FIG. 2) for driving the conveyer belt 20 by means of a feed drive motor 25.

The feed drive motor 25 is connected by toothed belts to the respective drive shafts 24 of the conveyor belts 20, such that the two drive shafts 24 are rotated at the same speed in the same direction. By monitoring the number of rotations of the feed drive motor 25 using a notch detector 25' for detecting the notches of the drive pulley, then the feed of the member 1 (FIG. 1) being fed can be accurately controlled.

With the feed device 18 of the present embodiment, in order to reduce lengthwise feed discrepancy which was found to occur when using a standard toothed belt conveyor belt, the conveyor belt 20 comprises metal hoop wires 26 embedded in a synthetic resin material 26' and is formed with a plurality of continuous grooves 27 formed around an outer peripheral surface of the conveyor belt 20 as shown in FIG. 4B. In FIG. 4 components the same as in FIG. 2 are denoted by the same reference symbols. Reference symbol 27' denotes the edge of a tooth of the toothed belt conveyor belt 20.

Each feed device 18 further comprises a clamping device generally denoted by arrow 28 (for clarity, only the clamping device 28 on the left side is shown in FIG. 2) mounted relative to the base structure of the saw bench 12, for clamping a member to being fed 1 against an outer peripheral surface of the conveyer belt 20 as shown in FIG. 4B.

With the present embodiment, each clamping device 28 comprises five clamping rollers 30 rotatably mounted on the end of finger supports 32 which are in turn secured to a clamping base 34. FIG. 5 illustrates the operation of the clamping device 28. The base 34 is mounted on the base structure of the saw apparatus 10 by means of linear bearings 36 at each end. By operation of a crank linkage generally indicated by arrow 38, using a pneumatic clamping actuator 40, the clamping base 34 can be moved along the linear bearings 36, thereby moving the clamping rollers 30 towards and away from the member being fed 1, and hence clamping this against the surface of the conveyor belt 20.

While not shown in the figures (only the monitor M shown in dotted outline in FIG. 5), operation of the feed device 18 is performed by a computer programmed with suitable software. This effects the necessary control of the drive motor 25 to give the required feed in either direction by detecting the rotation of the drive motor 25 with the notch detector 25' and sensing the location of the material being cut with four position sensors 41 arranged along the feed path Y. The computer also controls the operation of the clamping device 28 to correspond with the feed operation, and the operation of the discharge actuator 17'.

Furthermore, the saw apparatus 10 comprises a circular saw blade assembly generally indicated by arrow 50 comprising: a base member 52 mounted relative to the saw bench 12 so as to be movable in a transverse direction X across the direction of feed Y, and a saw blade mounting device in the form of a blade drive assembly generally indicated by arrow 54 (see FIG. 6 and FIG. 7) for rotatably mounting a circular saw blade 56 on the base member 52 at a predetermined angle α relative to the transverse movement direction X of the base member 52 in the plane of the saw bench 12.

The base member 52 is mounted on the main structure of the saw apparatus 10 by means of linear bearings (not shown) so as to be freely movable in the transverse direction X. As shown in FIG. 6, this transverse movement is provided by means of a toothed belt 58 which is clamped to the base member 52 with a clamp 60, and which is moved up and down by means of a transverse drive motor 62 connected by a toothed belt drive 64 to the toothed belt 58. The transverse movement of the base member 52 can thus be accurately controlled by detecting the rotation of one of the tooth wheels of the toothed belt drive 64 using a notch detector 64', and outputting a detection signal to the computer. The computer uses this signal in co-ordinating and synchronising the transverse movement of the circular saw blade assembly 50 with the feed operation by the feed device 18.

Moreover, flexible plastics sheets 66 are stretched on either side of the base member 52, and tensioned by cables 68 which pass around four pulleys 70 mounted on the frame. These sheets 66 prevents material and saw dust from entering into the rear region of the saw apparatus 10.

The blade mounting device 54 includes a bearing and spindle 72 for mounting the blade 56, and a blade drive electric motor 74 for driving the circular saw blade 56 via a toothed belt and pulley drive 76.

The blade drive assembly 54 is mounted on the base member 52 by an angle adjusting device generally indicated by arrow 78. The angle adjusting device 78 comprises blade end bearings 80 for rotatably supporting the peripheral edge at the blade end of the blade drive assembly 54 relative to the base member 52, and a pedestal bearing 82 (FIG. 7) for rotatably supporting the base end of the blade drive assembly 54. The angle adjusting device 78 further includes a toothed belt drive 84 which is driven by an angle setting motor 85. The angle α of the blade 56 can thus be accurately controlled by detecting the rotation of one of the tooth wheels of the toothed belt drive 84 with a notch detector 85' (FIG. 7) and outputting a detection signal to the computer. The computer uses this signal in co-ordinating the angle setting of the blade 56 with the

transverse movement of the circular saw blade assembly 50 and the feed operation by the feed device 18.

By means of the angle adjusting device 78, the blade angle α can be adjusted through a full 360 degrees by appropriate control of the angle setting motor 85.

Moreover, the saw blade mounting device 54 further comprises a blade depth adjustment device generally indicated by arrow 86 (FIG. 7). The blade depth adjustment device 86 comprises an adjustable mount in the form of two linear bearings 88, between a base member 90 of the saw blade mounting device 54 and a moving member 92 on which is mounted the bearing and spindle 72 and the blade drive electric motor 74. An actuator 94 is provided between the base member 90 and the moving member 92 to move the moving member 92 and thus move the blade 56 to adjust the depth of cut. The blade depth can be controlled by means of a detent device 96, which can be turned into or out of the path of movement of a lug 98 on the side of the moving member 92. Operation of the detent device 96 can also be controlled by the computer to suit requirements.

The saw apparatus 10 of the embodiment also comprises a saw dust removal device generally indicated by arrow 100 (FIG. 6 and 7) for removing saw dust as this is discharged from the cut. The saw dust removal device 100 comprises an intake 102 (FIG. 2) which surrounds the saw blade 56 so as to be in the vicinity of the teeth exiting from the cut, and a suction duct 104 connected to the intake 102 for drawing air in through the intake 102 by means of a flexible suction pipe 106 which is connected to a standard suction type dust removal device (not shown). As shown in the figures, the suction duct 104 also constitutes a hollow support member of the circular saw blade assembly 50.

The operation of the saw apparatus 10 of the present embodiment will now be described with reference to the flow chart of FIG. 8.

The case for making angled cuts in elongate members 1 such as the truss and framing members for a house, as described beforehand with reference to FIG. 1, will be considered.

At first in step 1 (denoted by S1 in FIG. 8 with subsequent steps similarly denoted), the computer is programmed with details of the cutting requirements, and the dimensions of the wood (material to be cut).

Then in step 2, the components are set to the initial position. For example the height of the blade 56 is adjusted by operating the actuator 94 of the blade depth

adjusting device 86, the angle of the blade 56 is set by operating the angle setting motor 85 to turn the blade 56 to the required angle α, and the blade 56 is moved away from the feed path Y (position "a" in FIG. 1), by operating the transverse drive motor 62.

Then in step 3, a first length of wood is fed to the feed device 18 by a separate feeder or by hand.

Next, in step 4 it is judged if there is a piece of wood on the conveyor belt 20, by sensing for the presence of a piece of wood with the proximity sensors 41 arranged along the feed path Y. If no wood is present, control returns to step 3 to allow wood to be fed.

When in step 4, the presence of a piece of wood is detected, control proceeds to step 5 to operate the clamping actuator 40 of the clamping device 28 to clamp the wood against the surface of the conveyor belt 20 with the clamping rollers 30. Here the wood is considered to be present when the wood is supported over at least 200mm of the conveyor belt 20 (as detected by the second sensor 41 when coming onto the conveyor or the third sensor 41 when going off the conveyor belt 20), to ensure sufficient support when operating the clamping device 28.

Once the clamping actuator 40 has been operated, control proceeds to step 5A to determine if measurement of the wood is required. If measurement is not required, control proceeds to step 6 to operate the feed drive motor 25 to move the conveyor belt 20 and feed the wood to the region of the saw blade 56.

Then in step 7 the saw blade 56 is rotated up to speed by the blade drive motor 74, and the sawdust removal device 100 is started. This step may be at an earlier stage depending on requirements.

Control then proceeds to step 8 for synchronous control of the transverse drive motor 62 (step 9) and the feed drive motor 25 (step 10) to move the wood into the cutting region at a predetermined speed, and move the blade 56 (which has been set at a predetermined angle in step 2) into the feed path Y (from position "a" in FIG. 1) at a predetermined speed. This synchronous operation is controlled accurately by the computer which co-ordinates the drive of the feed drive motor 25 and the transverse drive motor 62 so that the wood 1 is continuously fed in the Y direction while the blade 56 is moved in the X direction from position "a" to position "d" in FIG. 1, to thereby cut the wood off at the required length and at the required angle.

Once the wood has been cut off, control then proceeds to step 11 where the clamping actuator 40 of the right side clamping device 28 is released to release the

clamping rollers 30. Moreover, the discharge actuator 17' is operated to move the minor support device 16 away from the feed path Y to allow the cut off end of the wood to fall down to a short length rack (not shown). In the case of long lengths of wood, the discharge actuator 170' of the outfeed device 140 is also operated to move the minor support device 160 away from the feed path Y to the other side to allow the cut off wood to fall down to the rack 180.

Then in step 12, the blade drive motor 74 and the sawdust removal device 100 are switched off (depending on requirements) and the blade 56 is retracted below (away from) the plane of the saw bench 12 by operating the detent device 96 and the actuator 94 of the blade depth adjusting device 86.

Control then returns to step 2 and the process is repeated.

If in step 5a, measurement of the wood is required, control proceeds to step 13 to perform a measurement routine as shown in FIG. 9. In step 14, the wood is fed as in step 6, with the distance fed being computed from the movement of the conveyor 20. In step 15 it is judged if the end of the wood has been detected by one of several infeed position sensors (not shown) positioned along the infeed path. The infeed sensors are arranged at one meter intervals along a five meter infeed path prior to the conveyor section. Once any of the infeed sensors detect the end of the wood, then in step 16, the length of the wood is computed, based on the distance fed by the conveyor and the distance of the relevant infeed sensor from the second conveyor sensor 41. Control then returns to step 6 to continue the subsequent operations as described above.

Other various cutting operations are also possible. For example the wood may be cut while being moved in the opposite direction (from right to left), or while the blade is moving upwards. In the case of upward cutting however, it may be necessary to provide sideways support to keep the wood firmly supported on the minor support rollers 16a.

While the feed device 18 of the embodiment has been described as a feed device for feeding material to the saw apparatus of the present invention, the feed device 18 is also applicable for feeding various types of material in other situations. For example, for feeding wood with a conventional horizontal saw bench type saw apparatus, or for feeding lengths of material in a nailing machine. The feed device of the invention with a plurality of continuous grooves around a peripheral surface of the conveyor belt is thus not limited to the feed device described in the embodiment, and covers feed devices for other applications. For example for feeding metals and plastics to various types of processing machines.

Furthermore, while the circular saw blade assembly 50 of the embodiment has been described in relation to the saw apparatus 10 of the present invention, a circular saw blade assembly of a similar construction comprising a base member able to be mounted relative to a saw bench so as to be movable in a transverse direction across a direction of feed, and a saw blade mounting device for rotatably mounting a circular saw blade on the base member at a predetermined angle relative to the transverse movement direction of the base member in the plane of the saw bench, and having a device for connection to a drive source for rotating a circular saw blade when mounted thereon (or comprising a drive device), is also applicable for use with other types of saw apparatus.

Moreover, while the saw dust removal device 100 of the embodiment has been described in relation to the saw apparatus 10 of the present invention, a saw dust removal device of a similar construction where the suction duct constitutes a hollow support member of the circular saw blade assembly, is also applicable for removing saw dust in other situations with other types of saw apparatus.

Furthermore, the invention is not limited to the saw apparatus 10 of the embodiment, where the saw bench 12 comprises two inclined support devices for supporting a length of material to be cut on a plane inclined at approximately 20 degrees to the vertical, but also covers saw apparatus where the saw bench is at other angles. For example the invention is also applicable to saw apparatus with conventional saw benches in a horizontal plane. Furthermore, the minor support device 16 need not necessarily be inclined at right angles to the support plane of the major support device 14, and may be inclined at other angles as required or desired.

Moreover, while in the above the description has been for where notch detectors are used for monitoring the number of rotations of the various motors, other methods may be more suitable. For example use of an encoder and/or a resolver incorporated into the feed drive motor may give much greater accuracy.

Furthermore, the outfeed device as described above is not limited to use with the saw apparatus of the present invention and may be suitably modified for use with other types of equipment requiring the features thereof.

INDUSTRIAL APPLICABILITY

The invention offers the following advantages in industrial application, however it should be appreciated that all such advantages may not be realised on all embodiments of the invention and the following list is given by way of example only as

being indicative of potential advantages of the present invention. Furthermore it is not intended that the advantages of the present invention be restricted to those of the list which follows:

1. By providing a feed device to enable cutting the material to be cut while being fed, angle cuts can be made with a small diameter blade compared to the conventional method of using a large diameter blade which is raised up through the material being cut. Moreover, the amount of transverse movement is much less than in the conventional case where the blade is aligned with the direction of transverse movement and is moved along the cut while the material being cut remains stationary. Furthermore, since the cut is through the timber rather than from beneath, the direction of sawdust is always on the outlet side of the cut, except perhaps at the final cut through the edge on completion of the cut.

2. By having the saw bench in the form of inclined support surfaces, a length of material to be cut can be positively supported on the saw bench by its weight holding it against the inclined surfaces. Hence alignment of the length of material can be easily achieved by using the weight of the length of material to position the length of material. Moreover, by having the saw bench inclined to the horizontal, the various components of the circular saw blade assembly can be more easily accommodated in the overall structure, and more easily accessed. Furthermore, having the saw bench at an incline overcomes the problem with conventional horizontal saw benches with wood cut offs, and chips collecting on the surface.

3. By using a conveyor belt feed device, the disadvantage in operating time with the conventional feed device which uses a pushing member is overcome.

4. By providing continuous grooves in the outer peripheral surface of the conveyor belt of the conveyor belt feed device, expansion and contraction of the belt with the applied loading can be absorbed by sideways deformation rather than lengthwise deformation, thus enabling accurate feed to be achieved.

5. By controlling the conveyor belt feed device described above, using a computer program, material being cut such as truss and framing members can be accurately fed to the saw apparatus in a controlled manner.

6. By providing a saw dust removal device where the suction duct constitutes a hollow support member of the circular saw blade assembly, the design can be made compact and the use of materials and components can be optimised.

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope of the invention as defined by the appended claims.